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ENERGY

No. 61

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CONTENTS

PROGRESS, POLICY IN POWER STATION CONSTRUCTION, EQUIPMENT REVIEWED

Moscow ZNAMYA in Russian No 2, Feb 81 (signed to press 28 Jan 81) pp 196-207

[Article by V.V. Krotov, USSR minister of power machine building: "The Nuclear Class of Quality"]

> [Text] "Provide for a significant build-up in equipment production in power engineering machine building for nuclear, hydroelectric and thermal electrical power stations, including nuclear reactors with capacities of 1 to 1.5 million kilowatts and power generation sets with capacities of 500,000 to 800,000 kilowatts for thermal electric power stations operating on low grade coals . . ."
>
> From the draft plan of the CPSU Central Committee for the 26th Party Congress "The Major Directions for Economic and Social Development of the USSR During 1981 - 1985 and the period up to 1990".

I

The generation of electrical power in our country in the last year of the 10th Five-Year Plan exceeded a trillion and 300 billion kilowatt-hours. The installed capacity of Soviet electric power stations reached more than 260 million kilowatts. The expansion of the scales of electrical power generation have made it possible to almost double the industrial power-worker ratio and increase the agricultural power-worker ratio by a factor of eight. The electrical power consumed for the everyday needs of people approximately tripled.

What do these figures indicate? Primarily, quantitative growth. But it would be impossible without the qualitative transformation of electrical power engineering: the most important component of our fuel and energy complex. Judge for yourself. As compared to the preceding five-year plan, the output of water operated turbines increased by one and a half times while gas turbine output increased more than

one and a half times . . . The unit capacity of steam turbines grew over this period from 300-500 megawatts up to 800-1,200 megawatts. A hydroelectric turbine with a capacity of 508,000 kilowatts was recently considered to be the largest in the world. And now, five turbines of 650,000 kilowatts each are in stable operation at the Sayano-Shushenskaya GES. The swift progress in nuclear power machine building is even more impressive. I recall that the first AES in the world, the Obninskaya, with a capacity of 5,000 kilowatts went on line in 1954. And in 1979, the Leningradskaya and Novovoronezhskaya AES's received the equipment for power sets with a unit capacity of a million (!) kilowatts. The output of nuclear reactors over the five-year plan has increased by a factor of 2.2.

Also needed were the scientific baggage and the capability of new theoretical developments as well as a developed industrial base and trained engineers, production process specialists and workers so as to embody the concepts of designers, which were at times unexpected, in actual high grade power engineering machines.

Our power machine construction which depended at the start of the 20th Century on the good will of foreign industrialists and had only small boiler plants, following the October Revolution acquired a solid independence based on a strong scientific and production base. True, in the prewar years, the nation did not dispense with deliveries from the outside. But foreign suppliers more than once violated the signed trade agreements. For example, American companies which in the 1930's undertook the fabrication of hydroelectric turbines for the Dneprovskaya GES which was under construction, sent only two machines to the USSR. We, naturally, got along without the foreign equipment. Turbines which were not inferior to the best world models were fabricated in a very short time at Soviet plants. This example eloquently attests to the fact that so-called economic sanctions against our country are not new, and attempts to complicate and slow down the economic development of the USSR were also made earlier. And how did all of this turn out?

Today, we ourselves are successfully selling complex power engineering equipment. Canada, Brazil, Norway, Argentina, Iceland, Morocco, Syria, Iran, Yugoslavia, Cuba, Iraq, Bulgaria, the GDR, Hungary, Rumania, Poland, the Chinese Peoples' Republic and other governments receive hydroelectric turbines, thermal mechanical equipment for TES's [thermal electric power stations] and power plants for nuclear electric power stations from the USSR. The "Loviza" AES which was built in Finland with the assistance of the Soviet Union is recognized as one of the best in the world in terms of engineering and economic indicators.

The scientific and technical revolution, having touched primarily industry, has dictated commandingly: it is essential to force the development of power engineering. For this, it was necessary in the interests of the national economy to combine enterprises producing different kinds of turbines, boilers, reactors, pipes and fittings into a single independent sector. Something which was done in the Ninth Five-Year Plan.

The Ministry of Power Machine Building was born.

II

To be sure, it is not worthwhile to change traditions which have developed, and for that reason I will begin the discussion of the scope of our work, traditionally, with hydroelectric power engineering.

Covered with honor, sung of by poets and rich in books devoted to it, today it is also, as they say, in the public eye. We are not only outfitting new electric power stations with equipment, the Nurekskaya, Zeyskaya, Kolymskaya . . . we are not only participating in an international division of labor, we are shipping products abroad: to Brazil, to the "Sobradinio" GES, to Argentina to the "Salto-Grande" GES, to Greece to the "Purnari" GES (in this case, foreign deliveries have not held up production of hydroelectric turbines intended for new construction products inside the nation) . . . A continuous process is underway for the reconstruction and expansion of old stations which have been operating for a long time. For example, the legendary Dneprovskaya GES. The enterprises of the Ministry of Power Machine Building manufactured turbines for it of 119,000 kilowatt each.

Leningrad scientists, designers and production workers created the largest water powered turbine in the world with a capacity of 650,000 kilowatts especially for the Sayano-Shushenskaya GES. At the maximum water pressure heads, it is capable of delivering up to 735,000 kilowatts. The first industrial model of this machine underwent some not altogether conventional tests, and sustained a wild outburst of the elements. In 1979, the flood on the Yenisey proved to be enormously greater than meteorologists forecasted. The well of the dam in which the turbine was located was flooded. When the water was removed from it and the unit was thoroughly inspected, it was found that the unit had stood up and following minor repairs, was capable of reliable service.

What else is characteristic of hydroelectric power construction? In the 10th Five-Year Plan, stations have been equipped which were erected in the European area of the USSR, in Kirghizia, Tajikistan, in Siberia and in the Far East. New power facilities have been created, as we see, specifically in those regions of the nation where they are most needed at the present stage of development of the overall national economy.

And there is yet another detail which is extremely important. The designers of dams and hydroelectric plants primarily take into account the nature of a river and the hydrology. It is well known that we construct GES's on quiet even rivers, on rivers where the conditions change from season to season as well as on rough mountain flows. In each individual case, it is necessary to choose the most expedient dam height and the optimal structural design for the turbines.

But recently, we have become far from indifferent as to how much and what land will be taken out of the agricultural turnover. The main thing is the overall

economic expediency, taking into account the advantage for this minute, but also for future decades a long way off from us. In other words, priority is given to the state solution and not the departmental one.

Here is a comparatively recent example. The first draft plan for the GES on the Nizhnaya Tunguska was rejected, although power engineers and power machine builders considered it quite enticing. The fact is that they decided to install turbines with a capacity of million kilowatts at this hydroelectric station. The concept was both attractive and technically feasible. Nowhere in the world are such large hydroelectric plants yet in operation. The prospect of approving the technical priority was alluring. And nonetheless, the initial project plan was rejected: too large an area of flooded land underneath the water reservoir, if the dam was constructed at the section line selected by the planners. It was proposed to them that additional research be done and another area be found where the water surface area could be reduced with the maximum possible depth of the artificial sea, and thereby, reduce the flooded area and save land and forest.

III

Supporting tradition, I have started with hydroelectric power engineering. But does this mean that its role is predominant in the fuel and energy balance sheet for the state? Not at all. Only about 20 percent of the generated electrical power falls to its share. While the needs of the national economy are growing every year. And production itself is becoming increasingly energy intensive and the lifestyle of people is improving. Residential and cultural construction is underway on a massive scale and the consumption of electrical power for household needs is increasing.

Under these conditions, there is one true course: the utmost development of thermal and nuclear electric power engineering. In this case, the major type of fuel at numerous thermal electric power stations will be coal. D.I. Mendeleyev, as early as the end of the last century wrote that burning oil and gas furnaces, i.e., the raw material for the chemical industry, means stoking the furnace with banknotes. The issue was that natural resources must be used efficiently with maximum advantage for society. The removal of petroleum, and then also gas from the fuel cycle will make it possible to substantially expand their refining for the production of industrial products and mass consumption goods.

Is there sufficient coal in the nation to satisfy the demand of the electric power stations of increased capacity? Geologists have answered this question of state importance affirmatively. And emphasized: an energy famine does not threaten the USSR in the next few upcoming centuries. Of course, natural resources of organic fuel are not limitless, and there is no reason to take life easy. But, nonetheless, we can assume that thermal power engineering is provided with fuel. And in the nation's fuel and energy balance sheet, it should take on itself about sixty percent of electrical power generation.

The reserves of coal are distributed nonuniformly in our country and they are of unequal value both in terms of quality and heat generating capability. There are fewer and fewer reserves in the European area of the USSR. In this case, coking coals are needed primarily for metallurgy, while the major riches are beyond the Urals. For an uninterrupted supply for the large thermal electric power stations in the European area of the nation, it is necessary to organize new long range shipments of millions of tons of coal. And moreover, the considerable strain placed on railroads will increase even more. Although, of course, to ship coal to the user - this is at first glance the natural solution of the problem which has come up. But this is not the best solution. There are also other variants.

It is no accident that powerful power generating complexes are now being established in the nation's east, in regions of large coal deposits. Such a complex will reach a capacity of 100 million kilowatts near the Kansko-Achinsk deposit. The construction there of 20-25 thermal electric power stations of four to six million kilowatts lies ahead. The coal for them will not be extracted from mines, but from pit excavations by the open pit mining method. The famous "Uralmash", where I served as directed in the 1950's and the start of the 1960's, not for the first time is going to manufacture giant excavators for such deep coal cuts. Minsk motor vehicle builders will supply large capacity dump trucks. As is easy to note, the plans for the future entail the strengthening and expansion of the machine building base. Otherwise, this extremely important matter for the state can stretch out over tens of years.

There is enormous and multifaceted work ahead. We shall note that to burn the coals of the Kansko-Achinsk deposit, special thermal-mechanical and coal pulverizing equipment is being designed, since the local coals have a high ash content as well as excessive moisture and, as the specialists say, a reduced resistance to pulverizing. And the scientific production associations for the study and planning of power engineering equipment imeni I.I. Polzunov and the Syzranskiy turbine construction plant have designed a special high performance air swept unit mill. And the TES's of the Kansko-Achinsk fuel and energy complex will be eqipped with series produced turbines of 800,000 kilowatts each in units with high capacity boiler plants. Each such unit has the height of an 11 story building. It is not difficult to come to the conclusion that the capital expenditures for the construction of thermal electric power stations will increase sharply. And so the scientific and engineering search goes ahead: such as using progressive methods of fuel combusion and designing a steam boiler of smaller dimensions.

Such a small unit has already been created. Its output is 500 tons of steam per hour. It has been installed at one of the electric power stations and is operating efficiently. Following experimental industrial operations, the small boiler will undergo yet another stage of refinement; it is proposed as the basis for the design of a steam generator for a block with a capacity of 800 megawatts. The new steam boiler is good in and of itself, though moreover, it will make it possible to curtail metal consumption as well as production and labor expenditures.

Capital investments in the construction of each station and the time required to bring them on line will be reduced.

It can be said that the thermal-mechanical equipment for the first stage of the Kansko-Achinsk complex has either already been designed or is in the final stage of the operational planning.

The first TES's though, which operate at full capacity, will also provide energy for KATEK [Kansko-Achinsk fuel and energy complex] industry and for the comprehensive energy production process refining of the Kansko-Achinsk coals themselves. Gas, resins, liquid fuel and low temperature coke, needed by the chemical industry, metallurgy and in some other sectors of the national economy will be derived from them.

It is clear that it is enormously more advantageous to transport these products over long distances rather than coal. The utilization of "its own" gas or liquid fuel at the thermal electric power stations of the Kansko-Achinsk fuel and energy complex will permit a reduction in the expenditures of the natural energy raw materials for the production of each kilowatt hour of electrical output. This will assist in the solution of one of the fundamental national economic problems: you see, the reduction in fuel consumption for the generation of a kilowatt of electrical power by only one gram will provide on a national scale for an annual savings of tens of millions of tons of fuel.

The Kansko-Achinsk fuel and energy complex, both in the first stage of its coming into being, and all the more in the future, is extremely important for the development of our economy as a whole and especially for the development of the forces of production of the eastern regions. It is planned that industrial bases will be expanded in the KATEK region which will produce mining transportation equipment, large steam boilers and other power equipment. It is planned that a large capacity repair base will be set up here for excavators, primarily for rotorary wheel excavators as well as for locomotives, electric locomotives, large load capacity dump cars, etc.

At the Krasnoyarskaya TETs No. 2 which is under construction and included in KATEK, a special facility will be constructed for the energy production process refining of coal, and a trial industrial autoclave type facility designed for reprocessing 30,000 tons of coal annually will be constructed at the Irsho-Borodinsk cut for the same purpose. The fuel obtained from these facilities will be quite transportable and will go to the western regions of the nation. This is one side of the matter. The other and no less important is the experimental check of the theoretical research in the field of the energy technology for brown coals and working out new methods of preparing them for utilization in thermal electric power stations and in the chemical industry.

Research and project planning collectives are studying the numerous problems in the thorough exploitation of the Kansko-Achinsk coal deposit, where these collectives belong to more than 60 ministries and departments. Institutions of

learning are also actively participating in this great work of state importance. The setting and development of KATEK is truly becoming a nationwide affair common to the whole people.

It is understood that the demand for power equipment for the KATEK TES's will increase in step with the increase in the extraction and energy technology reprocessing of the coal. The associations and enterprises of the Ministry of Power Machine Building will supply several tens of sets of equipment for power units with capacities of 800,000 kilowatts each to just the first series of TES's, the construction of which is planned the upcoming 10 to 15 years. In order to handle such an extensive program and provide for satisfying KATEK needs in the long term, the existing enterprises in our sector are being expanded and new ones are being created. In particular, the decision has been made to construct a power machine building plant in Bratsk; its first stage will begine the production of boiler shells and welded metal structures, i.e., the largest and most metal consuming products which are inconvenient to transport over great distances.

It is planned that production capacities in the "Krasnyy kotel'shchik" and "Sibenergomash" associations and in the Belogorod Plant for Power Engineering Machine Building will increase by a factor of one and a half. A substantial contribution to the creation of KATEK will also be made by the Volgodonsk Plant for Power Engineering Machine Building, the cornerstone of which was laid in April of 1979. This enterprise will deliver various boiler auxiliary equipment to the thermal electric power stations.

We consider the problems of outfitting the Kansko-Achinsk fuel and energy complex just as important as the problems of increasing equipment production for nuclear electric power stations.

Along with KATEK, fuel and energy complexes are also being set up based on the Pavlodar-Ekibastuz, Kuznets and other coal deposits. The coals in them differ in terms of the ash and moisture content, as well as the ash composition. And so it is necessary to design custom-made boilers with specific furnaces and individual slag removal.

IV

Domestic thermal power engineering is based on the solid foundation of the great theoretical achievements of worldwide science and practice. Until recently, all of the equipment of thermal electric power stations was designed on the basis of classical principles, formulated as early as the middle of the last century by the French physicist Carnot, one of the founders of thermodynamics. However, the modern scientific and engineering revolution, which is marked by a critical review of many of the established tenets of science in practice, had forced designers to encroach on all but the very fundamentals of thermodynamics. For example, specialists of the Scientific and Production Association imeni I.I. Polzunov, in cooperation with other scientific collectives and plant workers, proposed that supercritical steam parameters be used in

thermal power engineering. This technically very brave step led to considerable reorganization in all sectors working on thermal power engineering. Stronger steels were required from metallurgists for the shells of boilers and steam turbine assemblies, especially for the turbine blades which sustain the greatest and nonuniform loads. Coal industry workers had to sharply improve coal quality and electrical power equipment plants had to change over to the production of more sophisticated control system for electric power stations.

In a word, the issue was the fundamental restructuring of numerous production processes which provide thermal power engineering with equipment and instruments. It is natural that prior to such a reorganization, it was necessary to undisputably demonstrate the economic efficiency of operating in the new way.

The theoretical calculations and economic justifications were reinforced by the operational experience with power blocks having capacities of 300,000 and 500,000 kilowatts. The results quite obviously testified in favor of the new: the metal consumption of the equipment per unit of power was reduced, the capital expenditures for the construction of the enterprises were curtailed and the expenditure of natural fuel per kilowatt-hour of electrical power was reduced. Additionally, the number of operational workers for servicing the new equipment is also curtailed.

Nothing is so convincing as practice itself, which either rejects a courageous concept as unfounded or confirms its undisputed right to life, improvement and development. In executing the tasks put forward at the 25th CPSU Congress, Soviet power machine builders have set up the series production of steam turbines with capacities of 500 and 800 megawatts [sic], designed a power unit for the Kostromskaya GRES, which includes a custom-made turbine with a capacity of 1,200,000 kilowatts and the largest boiler plant in the world; it is planned that it will be brought up to full capacity by the start of the 26th CPSU Congress. By the way, there is as yet not a single turbine abroad which exceeds the Kostromskaya in terms of power and utilized steam parameters. Soviet thermal power engineering is confidently maintaining the lead in this field.

It stands to reason that the research is continuous and thermal mechanical equipment will be further refined in the future.

The technical re-equipping of domestic electrical power engineering is one of the greatest and most important national economic tasks. In solving it, it is necessary to also take in world experience and to intelligently utilize all of the best produced by Soviet science and engineering. No matter how rich we become, we should be assiduous masters, decisive in everything and should learn to see not only the advantage of the minute, but also the final results. V.I. Lenin called for this in his time. General Secretary of the CPSU Central Committee and Chairman of the Presidium of the USSR Supreme Soviet L. I. Brezhnev has also repeatedly spoken of this in his addresses.

In acquiring experience in the fabrication of increasingly complex power engineering equipment, the workers of our sector are persistently working on the thermal

machines of the future. The idea of a steam generator designed for a working pressure of 10 atmospheres has come up. Is it needed? In our opinion, it is needed, and primarily because, judging from preliminary developmental work, it will be highly productive and economical. In particular, the metal consumption for the fabrication of the heating surfaces will be reduced by a factor of about 2.5. And naturally, the dimensions of the new steam generator are comparatively small. This means that its shell can be transported via railroad and water routes in a state of maximum plant readiness. The issue is not only one of transportation. In referring to the concept of "maximum plant readiness", we have in mind that the plant assembly is preferable to assembly on site; the operational performance of each assembly can be studied more carefully at the plant and a longer guarantee can be made for its reliability.

There is also another no less important aspect. The delivery of power engineering equipment in a state of maximum factory readiness presupposes the standardization of the designs of conventional thermal and nuclear electric power stations. Individual designs are still developed for each TES and AES. Why? The project planners refer to tradition and speak of the striving to experiment a little. But the necessity of finally developing standard project plans for buildings and the equipment layout of thermal electric power stations is already clear. Standard project planners for TES's and AES's will avoid the complexities for power machine builders related, for example, to the individual fabrication of a set of pipes. A unified scheme will curtail the number of components of the fuel preparation equipment and will make it possible to specialize the fabrication of the major assemblies. And this will in turn lead to an improvement of plant technology, an increase in quality and a shortening of equipment manufacturing time. The builders will also gain a direct advantage. Standard documentation will make it possible for them to order in a timely manner, shall we say, the reinforced concrete structures for the TES and AES buildings, and prepare the foundations under the power equipment for installation within curtailed timeframes.

All of this will not only improve operation of the sector but will assist in the capital construction, the state of affairs which has been noted to no small extent in recent Plenums of the CPSU Central Committee.

V

At one time, one of the sights in our cities, especially out-of-the-way cities, was the smokestacks of furnaces and small boiler plants. There are fewer of these stacks now. The landmark of the new era is municipal thermal electric power stations, where heat production and electrical power generation are combined. The overall efficiency of such power plants is continually increasing.

The successes of the Soviet state in providing central heating for cities are considerable. District heating permits a reduction in the specific fuel expenditures, an improvement in the structure of the fuel balance and an increase in heat supply reliability. Expanding the scales of district heating right up to

the centralized supply of electricity and heat to the residences of the rural populace is one of the major tasks of Soviet power engineering.

Another of our tasks is gas pipelines.

It is well known that over the last 15 years, numerous oil and gas deposits have been prospected and placed in service in the territory of the Western Siberian oil and gas bearing region between the Yenisey and the Urals range. In order to get gas from these remote difficult to reach regions to industrial centers in the European area of the USSR, as well as for exports, gas pipelines have been laid and enormous new gas transport systems have been planned and are under construction. The trunk line from Nadym--Punga--Nizhnyaya Tura-Ukhta--Torzhok to the USSR western border recently started operation and the construction of the Urengoy--Chelyabinsk--Tsentr gas pipelines has been expanded. These large scale high capacity enterprises are needed by the national economy and they will assist in expanding external economic ties, especially with nations of socialist cooperation.

If we follow, shall we say, along the route of any gas pipeline in a helicopter, you will see accurate standard compressor station structures. The gas repumping plants for these stations are fabricated by enterprises of the Ministry of Power Machine Building.

As early as the outset of the 1960's, operational experience with the Stavropol' to Moscow gas trunk line confirmed the correctness of the decisions which had been made: expand the series production of turbine gas pumping plants in the shortest possible time, where these are the most economical and well equipped for operation at compressor stations on major gas pipelines.

To design a reliable gas turbine plant, which would be able to maintain the gas pressure in large diameter pipes, run over enormous distances, was extremely difficult. The design problem was to obtain thermal energy in one unit by burning fuel, and by converting this energy to mechanical energy, couple it to the booster pumping the gas. It was actually necessary to combine several specific features and functions in one machine which were inherent in a boiler, turbine and generator of a steam turbine plant.

In order to speed up the solution of this specific problem, the personnel of all of the nation's turbine construction enterprises were called on and the simultaneous design and production of several types of gas pumping plants was organized.

The first pumping plants were imperfect and inadequately reliable in operation. Then the collective of the present day "Nevskiy Zavod" production association imeni V.I. Lenin designed a gas pumping plant with a power of 10,000 kilowatts, which was awarded the state Seal of Quality; and in the last year, completed the developmental work on a new turbine plant with a capacity of 25,000 kilowatts. It is now undergoing industrial tests at the Novgorod compressor station.

The production of gas pumping plants of various capacities was also assigned to the "Turbomotornyy zavod" production association imeni K.Ye. Voroshilov and the Khabarovsk power machine building plant, where strong collectives of designers, production process engineers and production workers were put together, striving to increase the production of a product so necessary for our gas industry.

At first, when this sector of the national economy was still coming into being, power machine building enterprises coped with its orders. The situation changed sharply at the end of the 9th and especially in the 10th Five-Year Plan. The demand for gas pumping plants rose greatly, while the existing production capacities proved to be inqdequate to completely satisfy the customer, the USSR Ministry of the Gas Industry. In recent years, the Ministry of Power Machine Building has been forced to turn to the "Leningradskiy Metallicheskiy zavod" production association, which specializes in the production of water powered and steam turbines, for the manufacture of gas pumping plants.

Since such a situation had come up, it was necessary to bring additional capacities on line. As early as 1974, the decision was made to construct an affiliate of the "Nevskiy zavod" production association imeni V.I. Lenin in the city of Chudova in the Novgorodskaya Oblast. The USSR Ministry of Construction, in immediately responding to the new assignment, organized a special construction subdivision on site. Everything went as if it had been set in motion for a long time.

However, six years later now, the construction and installation work on the facility in Chudova has hardly been half finished. What has befallen the construction site? Nothing like any natural disasters have rained down on it or on the quiet city . . . it turns out, during all six years, in taking their time constructing the affiliates, the local management attempted to solve their own intracity and regional problems themselves. The builders and installation workers left. The material resources allocated for the affiliate were used for local construction projects. Petty needs pushed the important business into the background. And the result is lamentable: both their own needs have not been satisfied and the affiliate is still not ready, the end of the construction is not in sight.

Meanwhile, the USSR Ministry of the Gas Industry not only continues to insist on increasing the production of gas pumping machines. It has given power machine builders an order for new, higher capacity booster pumps. Right now, the gas pressure in the trunk pipelines is 7.5 megapascals. Up until quite recently, this suited everyone. But then the necessity arose of boosting the carrying capacity of pipelines so as not to lay additional lines. For this, it was necessary to increase the pressure up to 10 to 12 megapascals. This means it is necessary to increase the capacity of the booster pump. Specialists are already designing a new machine and will soon send production workers the working drawing of the assemblies. It is obvious that the drive turbine must be modernized or a new one designed, which in conjunction with the booster pump will also form a gas pumping plant. In a word, new capacities brought on line at Chudova on time would prove to be most welcome.

VI

As is well known, the Soviet Union is not experiencing any shortfall of natural energy resources. The reserves of petroleum, gas and coal to the east of the Urals have not been fully evaluated yet. The resources of the rivers of Western Siberia and the Far East have not been completely exploited either. And we are developing these riches in a consistent and planned fashion, increasing the pace of their mastery from five-year plan to five-year plan.

However, in carefully managing natural resources, we should take into account the fact that about 90 percent of the fuel and 80 percent of the hydroelectric energy reserves are located beyond the Urals range. And more than 70 percent of the electrical power being generated is consumed by central and western regions. It is of course possible to transfer the enormous quantities of fuel to the center and west and to run ultralong electric power transmission lines - in the absence of economically more favorable variants. Moreover, the "main developmental trends for the USSR national economy for 1976-1980", adopted by the 25th CPSU Congress and which have basically been implemented, provided for a different solution: an advanced pace of development of nuclear power engineering in the European area of the USSR.

In contrast to thermal power stations using conventional fuel, AES's practically do not pollute the atmosphere. And while the per unit capacity of conventional thermal electric power stations is limited to a maximum of four to six million kilowatts, there are no such limitations on AES's. The operation of breeder reactors at the Shevchenkovskaya and Beloyarskaya AES's solves yet another extremely important problem of nuclear electric power stations: the fuel problem.

USSR nuclear power engineering will grow stronger and more mature with each five-year plan. Now, one of the tasks of the 25th CPSU Congress has been successfully fulfilled: the design of the power equipment for thermal neutron AES's with capacities of 1,000,000 and 1,500,000 kilowatts.

It may be that some day AES's will take second place, having become inferior to other sources providing light and heat to people. The containment of a thermonuclear reaction is continuing; in regions where there are many sunny days, solar electric power stations will be constructed, since the sun is the most reliable unexhaustible source of energy; hydrothermal sources are being placed in service every year, of which there are no few number in the USSR, and they are playing a definite role in the overall fuel and energy balance of our state. . . . . and recently, a report was published in the press on the design of electrochemical generators, which use gaseous hydrogen and atmospheric air. The efficiency of these generators can theoretically reach 100 percent. In the long term, one will be able to put together a high capacity electric power station from them, which is absolutely "clean" from the viewpoint of ecology and protecting the environment. . .

But the basic forecasts for the future are nonetheless related to the development of nuclear power engineering. Developmental work on special equipment for nuclear heat and electric power stations (ATETs) and nuclear heat supply stations (AST's) is now continuing at full speed, where these will accelerate the supply of our cities and populated areas with heat and light.

Along with this, power machine builders are continuing the improvement of power plants intended for industrial AES's. The issue involves primarily special turbines. In this case, all of the achievements which have been accomplished by scientists and production workers are utilized in constructing and fabricating turbines with capacities of 800 and 1,200 megawatts.

The "Izhorskiy zavod" imeni A.A. Zhdanov, "Khar'kovskiy turbinnyy zavod" imeni S.M. Kirov and the "Leningradskiy Metallicheskiy zavod" production association have set up the production of reactor vessels and turbines which stand up to the so-called "bath effect", i.e., are capable of operating reliably in moist steam. In executing the decision of the staff of our ministry - manufacturing the future high speed turbines for AES's - the experimental collective of the "Leningradskiy Metallicheskiy zavod" is working persistently on designing such a machine with a capacity of one million kilowatts.

The reactors and turbines constructed at the enterprises of our sector are going to the Novovoronezhskaya, Leningradskaya, Chernobyl'skaya, Kalininskaya, Smolenskaya, Yuzhno-Ukrainskaya and other nuclear electric power stations. To speed up the complete deliveries of equipment intended for these stations, the production base of the Ministry of Power Machine Building is being reconstructed and expanded. The transformations have been taken over by the "Khar'kovskiy turbinnyy zavod" imeni S.M. Kirov, the "Krasnyy kotel'shchik", "Leningradskiy metallicheskiy zavod", the "Izhorskiy zavod" imeni A.A. Zhdanov, as well as the Belgorod and Chekhov power machine building plants. . .

The construction of "Atommash" is continuing.

There are symbols for each city which express the nature and idea of the labor of its populace. The 30 year old Volgodonsk, which has arisen on the shore of the man-made Tsimlyanskiy Sea because of the channel joining the Don and Volga, would most likely have inscribed the grapevine, a hydroelectric turbine rotor and a modest chemical formula in its own emblem. But in 1975, its fate changed abruptly. The construction of "Atommash" was expanded. And now the city's coat of arms is the electron orbit around an atomic nucleus.

The outlines of both the custom built "Atommash" and the new city are already clear.

The large capacity first frame, similar to an ocean liner when seen from far off, the tidy third frame, the second, fourth and sixth which are being completed as well as the installation cranes and the intervoven transport roads make an indelible impression. The concepts of the architects and production process

engineers are being realized by the collectives, which include no few number of builders who erected the Volkohv aluminum plant, the Kama motor vehicle plant, as well as the cities of Tol'yatti and Naberezhnyye Chelny . . .

The hour is not far off when "Atommash" will take its place among the "Izhora", "Uralmash", "Rostsel'mash", the Volgograd tractor plant, the Kuznetsk metallurgical combine, the Moscow and Gor'kiy motor vehicle plants, the Sayano-Shushenskaya GES and other giants of our industry. Or rather, it will exceed them in some respect.

In ordering the production process equipment for "Atommash", specialists had to decide the following: either to install traditional machine tools in this enterprise, and then have the unavoidable retrofitting comparatively soon after the completion of the construction, or whether to provide early in the planning stage a set of the latest equipment for "Atommash": machining centers, welding units, hoisting cranes, tempering furnaces, nondestructive quality control equipment, etc., which would exclude the very idea of retrofitting in the forseeable future. They have chosen the second "route", although it proved to be considerably more complex and somewhat longer.

The tactics and strategy for the construction of "Atommash" are completely in line with the accelerated pace of the development of our entire fuel and energy complex which was established in the middle of the 10th Five-Year Plan. Right now, "Atommash" is orienting project planners of nuclear electric power stations towards typical standardized design. The preparation of the project plan for a standard AES opens up the possibility of organizing a unique construction conveyor line and reducing capital investments in each subsequent nuclear electric power station. A standard AES project plan is the realization of thoroughgoing specialization in nuclear machine building; it is the utilization of the advantages of series production in the output of AES equipment for the long term and it is also the transition to the fabrication of large blocks of a higher unit capacity based on the comprehensive organizational labor which provides for a high reliability category of the equipment for AES's.

In our opinion, the nation has the scientific, project planning and production base which is adequate to dispense with the individual project planning of large nuclear power engineering facilities and to also move onto standard project plants, which are economically more advantageous both in the construction and in operation. In the final analysis, the time has come when it is necessary to create an in-house design center in the system of Ministry of Power Machine Building, which would take on itself the responsibility and all concerns related to the development and production of equipment for AES's. Many years of experience in hydroelectric and steam turbine construction, as well as a similar situation in all other machine building sectors, confirm the timeliness of such a solution. The creation of a single design center will make it possible to do without the multiplicity of various kinds of coordination efforts of documents and engineering proposals, especially nontraditional ones, which take years today and something which costs the state dearly. This will accelerate the production of new types

of more sophisticated power engineering equipment for AES's for various purposes, and will undoubtedly improve its reliability.

VII

"Workers Competition", "Work Without Falling Behind", "We Build It Ahead of Schedule - We Bring It on Line Ahead of Schedule" - these are the major directions of socialist competition in the 10th Five-Year Plan, proposed in the Ministry of Power Machine Building system by the collectives of the "Krasnyy kotel'shchik" and "Atommash" production association, have been approved and recommended by the CPSU Central Committee for universal dissemination.

The "Workers Competition" came up during the construction of the Nurekskaya GES, and is now successfully in force for the construction of the Sayano-Shushenskaya GES. What is the essence of it? The builders, installation workers and suppliers of equipment, scientists and project planners conclude a collective agreement on socialist competition, established deadlines for the execution of the obligations they have accepted and by means of a coordinating council, strictly supervise these deadlines and the work quality, in other words, the entire area covered by the "Workers Competition". The completion of the Nurekskaya hydroelectric power station ahead of schedule and the course of the construction of the Sayano-Shushenskaya have clearly and convincingly confirmed the effectiveness of this direction of socialist competition.

The collective of the "Krasnyy kotel'shchik" in the city of Taganrog came out with the initiative "Work Without Falling Behind". The undertaking of the boiler makers found approval and support in the Taganrog municipal committee, and thereafter also in the Rostovskaya Oblast party committee. As is well known, all of the oblast enterprises entered into this competition as a result of the enormous organizational and mass political work of the party organization of the Don.

A program has been developed and is being persistenly implemented in which the following are involved: the education and teaching of workers, the timely rendering of assistance to those who get behind, the improvement and monitoring and increasing the responsbility of personnel, from the worker to the director, for the fulfillment and overfulfillment of the shift, monthly, quarterly and annual plans, as well as for the five-year plan as a whole. And while several tens of lagging enterprises were still counted in the Rostovskaya Oblast in the middle of the 10th Five-Year Plan, today practically all of the associations, plants and factories are successfully coping with the plans for product output and the introduction of new equipment.

The collective of the "Atommash" Volgodonsk production association for nuclear power machine building came forward in the penultimate year of the 10th Five-Year Plan with the call "we build it ahead of schedule - we bring it on line ahead of schedule". This initiative embodied the striving of the builders and the installation and operational workers to more rapidly complete major facilities of this

flagship of domestic nuclear power machine building, bring it up to the planned production volumes, and by the opening of the 26th Congress, manufacture the first frame for the Don reactor. The patriotic initiative of the Atommash workers was approved by the CPSU Central Committee and disseminated through the nation.

Volgodonsk and "Atommash" get special attention in our ministry. They become more mature every year. Prior to the start of construction on "Atommash", Volgodonsk was a city with a somewhat provincial appearance: modest two and three story houses were lost among the green poplars. The new Volgodonsk is provided with wide avenues, public parks and spacious squares and 9 and 12 story buildings. The residential districts are linked to the industrial region by a trolly bus line.

However, the impact of "Atommash" is felt not only in the fact that the appearance of the steppe city has changed. It goes much deeper. "Atommash" is now having a perceptible impact on the way of thinking, the professional orientation and the attidue of people to the quality of their work. As before, remaining young and energetic the Volgodonsk residents understand the special features of the production of nuclear power engineering equipment and produced products not simply of a high quality, but of the so-called nuclear class of quality.

In the CSPU Central Committee plan, "Major Trends in the USSR Economic and Social Development for 1981-1985 and the Period up to 1990", it is stated that power machine builders are confronted with concentrating their efforts on expanding the production base and improving technology so as to handle not only the new larger assignments, but also to raise the manufacture of power equipment, especially for AES, to another qualitative level. And it is enormously higher. For we should supply electrical power engineering, primarily nuclear engineering, with equipment having capacities of 1 to 1.5 million kilowatts in a single block, fast neutron reactors with capacities of 800 and 1,600 megawatts and thermal power engineering with equipment having unit capacities of 500 and 800 megawatts which is capable of utilizing low grade solid fuels. In essence, we have proposed for the first time that equipment be designed for heat supply nuclear stations, as well as steam-gas plants with solid fuel gasification.

The "Main Trends" plan, which has been submitted for national discussion, is yet another convincing confirmation of the consistency and dynamic nature of our party's policy, for which there is no higher and nobler purpose than the constant and utmost improvement in the well being of the Soviet people. We consider our own practical activity in the development of electrical power engineering from this same party point of view. The weightier our contribution to the construction of hydroelectric, thermal and nuclear electric power stations, the more fully the needs of industry and agriculture will be satisfied for electrical and thermal power, the more comfortable the everyday life of the Soviet peoples will become and the greater will be the power of our socialist motherland.

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EFFICIENT BUILDING OF MAIN OIL, GAS PIPELINES DISCUSSED

Moscow PLANOVOYE KHOZYAYSTVO in Russian No 4, 81 pp 49-58

[Article: "Efficient Use of Material and Labor Resources to Build Main Oil and Gas Pipelines (Roundtable Meeting of the Journals PLANOVOYE KHOZYAYSTVO, KHOZYAYSTVO I PRAVO, MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, and SOTSIALISTICHESKIY TRUD)"]

[Text] The forced development of the West Siberian oil and gas complex is one of the stages determining the turn of the national economy towards solving diverse tasks associated with improving the welfare of the people. The importance of this complex lies in the natural reserves of hydrocarbon raw material. They make it possible to select the optimal structure of the fuel and energy balance, accelerate the growth of the chemical industry and other sectors, and more completely satisfy the needs of the countries of socialist cooperation.

The role of West Siberia in implementing the economic policy of the Communist Party was noted at its 26th Congress. It remains to make extraction of oil and gas and their transporting to the European section of the country the most important links in the power engineering program of the 11th and 12th Five-Year Plans.[1] The base for this has been created. In 1980, over 312 million tons of oil (with gas condensate) and 156 billion m^3 of gas were extracted from the depths of northwest Siberia.

The collectives of oil workers, gas workers, buildiers and all those engaged in the oil and gas industry of the Tyumenskaya Oblast received with inspiration the greeting of General Secretary of the CPSU Central Committee, Chairman of the Presidium of the USSR Supreme Soviet L. I. Brezhnev. It highly evaluated their work in the 10th Five-Year Plan. "The prominent achievements," the letter states, "were the result of coordinated creative labor of thousands of workers, engineers, scientists, technicians and personnel in developing the oil and gas wealth of West Siberia, the active work of many labor collectives in the country to provide the oil and gas complex with the leading equipment, equipment and materials, and the great political and organization activity of the party, soviet, trade union and komsomol organizations."[2]

The Main Directions for Economic and Social Development of the USSR for 1981-1985 and for the Period to 1990 stipulate an increase in the quality of construction of facilities of pipeline transportation and their reliable operation, considerable growth in output of the constructed gas pipelines, implementation of measures to

increase the automation of compressor stations, and develop and introduce technology of year-round construction of pipelines in regions of difficult access with complicated natural and climate conditions.[3] The realization of this requirement obliges all the participants in the construction of oil and gas mains that are characterized by great length and mobility o' the work front to do a lot.

The quality of planning, technical progress, accurate deliveries of equipment, pipes and machines to the start-up facilities and routes to be laid, strengthening of the work discipline, high organization of labor, and timely creation in the regions to be developed of the production, social and general infrastructure become the decisive factors in the fulfillment of the production programs. The urgency of these questions was the impetus for a roundtable meeting of the journals PLANOVOYE KHOZYAYSTVO, KHOZYAYSTVO I PRAVO, MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE and SOTSIALISTICHESKIY TRUD, and representatives of the party, economic, trade union and komsomol organizations of Tyumen' and the Tyumenskaya Oblast. The meeting that took place in early February 1981 discussed the problem "The Efficient Use of Material and Labor Resources in Building Main Oil and Gas Pipelines."

Below is a published report of the course of the meeting.[4]

In characterizing the economy of the oblast, B. Trofimov, head of the department of the Tyumen' obkom of the CPSU, noted the contribution of the workers to the development of the oil and gas industry. During the 10th Five-Year Plan, the increase in oil extraction (including gas condensate) in the oblast was 165 million T, and of gas 122 billion m^3. More of these products are extracted from the depths of the Tyumen' fields than all the fields of the country yielded 16 years ago. According to the calculations of the scientists, in the future the gas output can be brought to 1 trillion m^3 per year.

Other data were cited at the 26th CPSU Congress. In the next five-year plan, it is necessary to produce almost the same amount of oil and twice as much gas as the previous 15 years. Their extraction in the created complex already exceeds 10% of the world extraction.

The largest gas transport systems begin in the north: Urengoy-Punga-Ukhta-Torzhok; Urengoy-Punga-N. Tura-Perm'-Kazan'-Gor'kiy-Moscow; Urengoy-Chelyabinsk and others. In order to supply Tyumen' gas to the central and western regions of the country, in the new five-year plan it remains to lay another 16,600 km of pipe 1,420 mm in diameter. This is 1.7-fold more than during 1976-1980. The output of the complex gas preparation unit in West Siberia will be increased by 102 billion m^3 per year.

Further development of the Tyumen' fields, B. Trofimov stressed, depends on the coordinated work of all the links in the oil and gas extracting complex, in particular, the builders of the pipelines, compressor stations, pumping stations and repumping stations and other structures. Pipeline transportation is one of the most economical and efficient subsectors, but at the same time it is materials and labor intensive. Under Siberian conditions, there are especially noticeable volumes of expenditures of all the types of resources for erection of facilities for the pipeline system. Their efficient use entails the perfection of interrelationships between all the participants of the construction. This is required by the decree of the CPSU Central Committee and the USSR Council of Ministers of 12 July 1979 on improvement in planning. The elimination of intersector and

and interdepartmental barriers is necessary from the viewpoint of national interests. Questions of planning and control of the production industry therefore occupied a central position in the discussion.

Deputy head of the all-union production association Tyumengazprom V. Tandalov, head of the Glavsibtruboprovodstroy [Main Administration for Construction of Oil Conductors and Pipelines in Siberia] N. Kurbatov, chief engineer of Giprotruboprovod [State Order of the Red Banner of Labor Institute for Planning Main Pipelines] V. Yalovskikh, and others spoke of the need to perfect planning of the construction-installation work. Its present volumes for the same facility, set by the customers (Ministry of the Petroleum Industry and Ministry of the Gas Industry) and the subcontractors (Ministry of Construction of Petroleum and Gas Industry Enterprises and Ministry of Industrial Construction) do not coincide. Similar disagreement consequently affects the use of material resources and the construction quality. Often the linear section of the pipelines is built faster than the surface facilities.

The plans must stipulate synchronism of work. In other words, the compressor stations need to be erected simultaneously with laying of the pipeline. The standardization of the facilities under construction, for example, the compressor stations, including a number of auxiliary and utility structures is poor. There are several existing oil pipeline drafts. It is difficult to achieve simultaneous construction of the storage battery units, heat- and water-conducting networks, etc. Their technical solutions for the same gas pipeline differ in the planning of the areas, the degree of engineering preparedness, design elements, the arrangement of the pipelines and auxiliary services. It seems that unification of the facilities should yield a great economic effect. In the opinion of the general director of the association "Sibkomplektmontazh," G. Shmal', by unifying the documents, 1 million rubles can be saved. An urgent need also arises for the construction drafts to be examined in a set.

Questions of the construction sequence have not been definitively resolved. The Glavsibtruboprovodstroy does not have a plan for the complex development of pipelines, although a plan of extraction for the fields does exist. It is also not clear where the pipeline will be laid. The central board needs to put over 4000 km of mainlines into operation in 1 year. From what point should the construction that is poorly correlated to the extraction plan begin? In asking these questions, N. Kurbatov essentially stressed the need for complex planning. It must be placed in the main preplanning document, the draft. Its quality, as N. Kurbatov and G. Shmal' assert, lags behind the requirements of modern construction. What, for example, should be the basis for the arrangement of compressor stations at a distance of roughly 100 km from each other? Why do the complex gas preparation units occupy large areas? According to the regulations, the central board is obliged to make remarks on the draft and to make corrections. However, this requirement is not observed. The draft is adopted without an expert's opinion, is approved and issued for further work.

This practice results in the fact that the engineering preparation of the areas for the compressor and oil pumping stations, and other facilities is often not done. This work is not provided for in the plans and is not financed. At the same time, removal of the ground, drainage, installation of approaches, etc. are necessary for access to the construction site. Because of the poor engineering preparation of the area, the construction of the Priob'ye compressor station was prolonged. Instead of 50,000 T of sand, 34,000 T were brought to the swampy construction site. The schedule for start-up of the station was interrupted.

Construction is primarily needed by the customer. But his representatives do not come to the open site, as G. Shmal' asserts. Self-elimination of the customer from controlling the process of construction (aside from allocating the money, transferring documents and signing the act of the working commission) results in unfinished and "worthless" work being found even at completed construction sites. The customer's responsibility under such circumstances is slighted.

Representatives of the organizations of the Ministry of Construction of Petroleum and Gas Industry Enterprises believe that "turn-key" turnover of the main pipeline facilities is possible on the condition that the entire investiture cycle, starting from the planning, is fulfilled by the builders. Concentration of the material, labor and financial resources in the hands of the subcontractor will prevent their diffusion and will exclude the unsubstantiated appearance in the drafts of construction sites that do not provide an increase in output, but are necessary to the customer for some reason. The estimated cost of construction is more reliable as a result. The organizations of the customer, it should be said, do not support this idea.

The head of the planning-economic administration of Glavtyumenneftegazstroy [Main Tyumen' Administration for Construction of Enterprises of the Gas and Petroleum Extracting Industry], N. Sergiyenko, shared his ideas regarding the use of the index of commercial construction product in planning.

Its introduction requires a new approach to the formation of plans. The facilities can only be brought to full readiness with accurate organization of the work, concentration of the available resources at the start-up complexes, correct determination of the need for materials, and elimination of nonproductive losses and expenditures. Material stimulation of the builders must depend on the fulfillment of the plan for introducing facilities and the delivery to the customers of completely finished pipeline sections. A. Novikov (head of the planning-economic administration of the Glavsibtruboprovodstroy) notes that everything still remains as before.

Flaws in planning are evident in the next example. In 1981 it is planned to build 960 km of gas pipelines and 4 compressor stations, while in 1984, 1,067 km and 4 stations. The cost of the work is doubling while the length of the pipeline practically is the same (the data were taken from the order record that is given to the Glavsibtruboprovodstroy). This example indicates the insufficient substantiation of the plans.

Planning of the construction-installation work should be started from below and should be implemented in several stages. Before 1 July, the Ministry of Construction of Petroleum and Gas Industry Enterprises and the customer ministries report control figures to the sites. During the month, orders must be agreed upon and signed, and the planning-estimate documents drawn up.

It is quite mandatory that examination of the records and agreement of the plans be started from the trust that has all the data and information necessary for this regarding the incomplete production. After correction in the central board, the records are sent to the ministry, the USSR Gosplan and in the opposite order after approval, to the central board. The schedule for introduction of each facility by quarters is set up directly in the construction organization. After this, the document is returned to the ministry.

Many shortcomings will be eliminated with this type of order.

In order to plan correctly, it is necessary to know the output of the construction organizations. There are several general techniques for determining the outputs that negate each other. A. Novikov believes that a technique is needed that takes into consideration the specific nature of the work separately in laying oil pipelines and gas pipelines, and others.

A. Sergiyenko noted that in the Ninth and 10th Five-Year Plans, such a planning indicator as the rates of growth of labor productivity were roughly triple in the central board than in the sector (in construction). However, one-fourth of the construction organizations that are included in the central board are not coping with the planned assignments. With their unconditional fulfillment, the volume of construction-installation work could annually be increased by 15-19 million rubles without an additional increase in the number of workers.

Some of those who spoke (N. Kurbatov, G. Shmal' and A. Sergiyenko) raised the question of the perfection of control over the construction industry. This process is natural. But with resubordination of the trusts in the middle of the five-year plan, the central board whose structure the trust has left, may not fulfill the plan for construction-installation work (if the trust overfulfilled it, being subordinate to another central board) and vice versa. It would apparently be more correct to consider the volumes of overfulfillment from the annual reports of the central boards for the appropriate years, and not at the end of the five-year plan.

According to the active statutes approved a decade ago, the maximum volume of work of the trusts is set at a sum of about 25 million rubles. They fulfill work of 170-180 million rubles with the previous staff schedule. But it is easier to set up a new trust than to reconsider the structure of the existing one.

Further, in Novyy Urengoy, for example, the builders, oil workers, gas workers and power engineers have autonomous automobile transportation services, communications systems, worker supply and even bakery. From the viewpoint not only of the builders of pipelines, but also national economic, from the aspect of developing the entire oil and gas complex it is necessary to coordinate the activity of various central boards, trusts, associations and enterprises. It will be implemented by an interdepartmental territorial commission under the USSR Gosplan with location in Tyumen'.

The most important condition for the formation of real plans for starting up facilities of the main pipelines is the correlation of the construction process with the schedules for supplying pipes, equipment, etc., i.e., with material and technical supply.

The shortage of warehouses, the necessary transportation vehicles and machines in a northern design complicates the work of the builders. Deputy head of the Glavtyumenneftgazstroy P. Nidzel'skiy characterized the use of equipment to build main oil and gas pipelines. Currrently, of the 5,500 transportation units of the central board, only 15% are in a northern design. The KrAZ's operate satisfactorily with small pressure drops from the viewpoint of Siberian conditions: from +25°C to -25°C. There is as yet no standard range for automobiles in the severe northern regime.

Today it is impossible to speak of the optimal use of construction equipment yet. The same excavators are operating in West Siberia as in other regions of the country. The machines that are supplied, not withstanding the "northern load," rapidly wear out. The windows freeze at -20°C at the tractor base of the first pipelayers of the Cheboksar tractor plant. The tractors need to be filled with several brands of oil.

Measures are currently being taken in order to have year-round construction. But this is being held back by the lack of roads on which freight is deliverd. The periods and cost of construction of the super-distant pipelines depend on the condition of the road communications in the Tyumenskaya Oblast. The transportation service is still behind in the rates of their construction. The Ministry of Transport Construction could participate more actively in building roads along the routes and within the fields.

The potentialities of river transportation are poorly utilized. The seasonal factor creates additional difficulties.

In the opinion of B. Trofimov, the efforts of the specialized organizations of the Ministry of Transport Construction should be concentrated on laying hardtop roads. Power transmission lines laid along the roads can yield an enormous benefit. Now the compressor stations are operating by using the current of nearby low-power power services. About 10% of the gas is spent on actuating the turbine units. If there was a power transmission line, all the gas could be fed on pipes without losses. The automation of the compressor stations would also be increased.

N. Kurbatov noted the insufficient rhythmicality of the machine deliveries. They are purchased in advance, but this factor plays almost no role in organizing the supply, since it is not always known when and in what quantity the equipment will be obtained. Supplied in a barrage, often the sheer quantity of pipes impairs their acquisition. There are not enough resources to pay for them and the bases are not designed for a single reception of excessive batches of pipes.

The head of the Tyumen' main territorial administration of the USSR Gossnab, V. Zaychenko, suggested that an additional section be included in the plans for construction. This section concerns material and technical supply. There is an extreme need for this. The planning institutes do not provide for the capital investments for the creation of warehouses, considering them to be second-rate facilities as compared to the sewage system, water network, telephone and radio circuit, etc.

According to the decree of the CPSU Central Committee and the USSR Council of Ministers of 12 July 1979 on perfecting the economic mechanism, supply will be implemented from working drawings and estimates. However, the lack of planning documents for material and technical supply creates definite difficulties. The transition to direct lengthy economic ties must be accompanied by the introduction of a system of material incentive for the suppliers, deliverers, transporters who fulfill the contract commitments conscientiously, and simultaneously by the strengthening of responsibility of the leaders of the manufacturing enterprises for nonfulfillment of the commitments.

It is expedient to set up extradepartmental reserves of materials for a guaranteed supply of equipment to the construction sites and for rapid elimination of the

malfunctions. The agencies of the USSR Gossnab at the sites have large, highly mechanized warehouses and are quite able to take on the function of distributing all the acutely needed products.

In the opinion of the head of the supply administration of the Glavsibruboprovodstroy, I. Okunev, the machines, equipment and construction materials that are intended for the construction sites of West Siberia and the extreme north should not be supplied in the fourth quarter, but before 20 August. His suggestion to review the materials consumption standard for construction is supported by V. Zaychenko. He believes that it is expedient for the central boards to organize a group or agency to control the storage and expenditure of material resources. In addition, the USSR Gossnab system needs to be given the right to redistribute the above-standard residues. The gas workers would not then keep the shut-off fittings "for reserve," while the oil workers need them. The time has come to build large warehouse complexes in such cities as Surgut, Nizhnevartovsk, Novvy Urengoy and Nadym. It would always be possible to rapidly send out the necessary materials to any facility.

Returning to the suggestion of reviewing the material resource consumption standards, it is necessary to remember the following. The balanced nature of the plans for starting up facilities is difficult to attain if there is no reliable standard base of planning. The standards of material consumption that were set at 1 million rubles of construction-installation work, are oriented on the fulfillment of assignments en masse. The system of standards is thus not linked to the final construction product. It does not take into consideration the increased wear of the equipment, seasonal standstills, the consumption of fuel and lubricants, etc. It does not pay attention to the effect on labor productivity of the natural-climate factor. The workers of the NIPIESUneftegazstroy [expansion unknown] believe that the standards for construction done by the organizations of the Ministry of Construction of Petroleum and Gas Industry Enterprises in West Siberia should be defined based on the actual working conditions in this region. Similar standards, based on specific experience and fiscal data, in their opinion, are a good basis for the planning calculations.

The chief engineer of the administration of main oil pipelines, V. Stanev, suggests that many losses can be avoided if standard documents are developed for construction in permafrost. It remains to enter this zone in the 11th Five-Year Plan. It should be reasoned out how negative buoyancy and destruction of pipes laid in the ground can be eliminated. There presently are no such construction standards. There are no test sites to check the reliability, wear-resistance, durability and other parameters of the pipes. Unfortunately, the planning institutes that are engaged in permafrost science have not been involved in solving the problems facing the builders of the Siberian pipelines.

The chief state arbitrator of the Tyumenskaya Oblast V. Zverev cited facts where undersupply of pipes and other equipment is aggravated by a careless attitude to commitments by individual officials. Another time, because of the lack of warehouses the materials were spoiled. The responsible agencies should think out the question of intensifying the material responsibility for violation of the rules of product storage and make the compensation for the damage caused more stringent. Charging of the fines to the funds of material stimulation should influence the cost accounting interests of the counteragent. V. Zverev believes that sanctions for poor management are mandatory. He indicated a number of omissions in the work of the state commisssions for inspection of the finished facilities. The inspection acts often mention the lack of a reserve to supply electricity, appliances, sewer system and approach roads that supposedly do not influence the operation of the

system and approach roads that supposedly do not influence the operation of the pipeline and the repumping stations. These cases should be qualified as a violation of the state discipline.

N. Kurbatov, G. Shmal', V. Zverev and P. Nizdel'skiy spoke of the negative phenomena associated with guaranteed safety of the transported freight. There is still no proper interaction between the transporters, railroad, sea, river, truck and air transportation. It is necessary to believe that placing full material responsiblity on the transporter for the cost of all the incomplete equipment, and not for the volume of lost parts will induce a real guarantee of load safety.

Those who spoke at the roundtable meeting linked measures aimed at the efficient use of material resources with the goals of effective management, and with the final results of the construction industry. Increase in the capacity of the pipeline systems, industrialization of the construction-installation work, and acceleration of the rates of scientific and technical progress are tasks whose resolution determines the final result to no less a degree.

N. Kurbatov concentrated the attention of the assembled on the need to increase the unit output of elements of the gas line route. Today the main consists of pipes 1420 mm in diameter, while the gas pressure in them is 7.5 MPa. The annual output of one loop is in limits of 30-35 billion m^3. These parameters are higher than anywhere in the world. Nevertheless, if one looks ahead, it should be said that the level of unit output of the system is insufficient. There is no economic substantiation for the transfer to greater pressure and greater diameter. The use of multilayer pipes will help the matter. But experiments are needed, in particular, in permafrost conditions. The client ministries (oil and gas industry) and their planning institutes would be able to build the appropriate experimental sections to work out a new technological regime of gas supply.

These measures are linked in the most direct manner to an increase in the efficiency of production and the efficient use of expensive pipes.

There is an indicator of the economic substantiation of the output of a compressor station for a certain pipe diameter. If they are 1020 mm, then the station must have three gas-turbine units with output of 10,000 kW (one operating, one in reserve and one in repair). If it is 1420 mm, then the unit output must be 25,000 kW. There are no such units, therefore eight machines provide the pipeline output. The problem, consequently, lies in the production of machines of high output at the enterprises of the Ministry of Power Machine Building.

The considerations regarding the realization of one of the progressive methods in construction, complete-block, that were advanced by G. Shmal' were of especial interest. The Main Directions for economic and social development of the USSR in the 11th and 12th Five-Year Plans indicate the need for its all-possible dispersal. The essence of the method is that the individual block-boxes (with built-in equipment and technological supply systems) that are made under plant conditions are united under a common housing.

Essentially the facility is not built but installed. The association "Sibkomplektomontazh" is engaged in this. It is the only one in the country (of the construction) that functions in a two-link structure, directly subordinate to the Ministry of Construction of Oil and Gas Industry Enterprises. The method allows facilities

to become turn-key operations with all the advantages that follow from this. In 1981, the association is ready (taking into consideration that a large part of the work is being done at the plants of the association) together with the administration of main oil pipelines to make one oil repumping station a turn-key operation (without considering the small construction sites, boiler houses, etc.). This small scope is the consequence of the disordered structure of the control over construction. For example, the mobile installation column (MIC) fulfills work of 15 million rubles. Not every trust is capable of this. Its organizational structure and staff schedule are the same as for an MIC with volume of work of 1 million rubles. It does not have the rights of enterprises, but they should be expanded.

Tens years of experience of complete-block construction in Tyumen' indicates its indisputable advantages. Previously one administration built an oil repumping station in 3-4 years. Now, one brigade of 50-60 people installs it in 5-6 months. If this method of construction was not used in Tyumen', then today's indicators for extraction of oil and gas would not be reached.

There are no opponents of the complete-block method. There are also no followers except the Ministry of Construction of Oil and Gas Industry Enterprises. At the same time, this method can be used to make radical shifts in the arrangement of productive forces. The base plants may have to supply blocks to the necessary point, where this is expedient. This is the main path of industrial construction. G. Shmal' believes that it is necessary to develop a complex target program for introduction of the examined method into the national economy.

Its introduction, however, is being delayed by supply shortcomings. For example, it is written in the active standard documents: in 7 months before the beginning of the quarter, the equipment should be at the association plant. But today, certain types of equipment have still not been delivered and their delivery periods were planned for last year. The fault for the failure lies with the customer. He must determine the sequence of construction of the facilities. The sanctions for interruption in the supply periods of equipment are ineffective. The obtained fines do not cover all the losses. In the opinion of G. Shmal', the customer must take bank loans and not the association. If it does not deliver the equipment on schedule, then it is obliged to pay the bank an increased percentage. The situation can be formulated as follows: the plans for equipment delivery are not balanced with the schedules for starting up the facility.

The block construction method can be used with great effectiveness if its advantages are linked to conservation of materials. The following questions arise: why do the units of complex gas preparation occupy large areas? Why is the weight of the employed compressors not 8 T but 45 T? Why do we have to deal with cumbersome pumps, engines and shutoffs? It is apparently worth thinking about the introduction of new materials into the technology of block production. Now the weight of the blocks reaches 230 T, and they can be made up to 500 T and more. Their delivery is only impaired by the lack of development of the transportation systems.

Complete-block construction is inseparably linked to qualitatively new forms of production organization and planning. The position of G. Shmal' is that the complex brigades need to have more rights and the plans should be oriented on the

brigade. If a kindergarten is built whose estimated cost is R 500,000, then it is better to give it to a brigade after setting the condition that the final calculation for wages will be made after the facility is finished. However, no one is following this path. It is authorized that a daily calculation be made for the work done. The shortcoming of this system is that it does not permit complete cost accounting to be introduced into the brigade.

The heads of the department of labor and wages of the Glavsibtruboprovodstroy, A. Paramonov and A. Belanov ("Tyumengazpromstroy") name other reasons. The enormous effect from the brigade contract is diminished, in the first place, because of continuous transfers of people and equipment from one work site to another (often thousands of kilometers), and secondly, because of the shortage of people. It is better for the brigade to be complex. There is no need to create, for example, a brigade of masons when there is mass construction using concrete panels and blocks.

The brigade foremen sometimes do not know the standards for materials consumption, say, for 1 km of pipe laid. How many electrodes, for example, are burned in welding one seam: 10, 15 or 20? Only experience makes it possible to compensate for the shortage of electrodes that often arrive broken and of poor quality. If some of the materials are lost on the way, then the workers' feeling of conservation is dulled. The brigade members must know the quantity of materials required for the work. Now they can only be set in the standards, but in no way can be conserved based on them. Certain points in the statute on the brigade order are outdated and need review. One of the characteristics of the contract is the plurality of occupations that significantly accelerates the working process. Here a welder, for example, in order to become a rigger counts on the appropriate payment. At the same time, the unified job evaluation reference does not contain an estimate for the work of a welder-rigger. It does not have this specialty (plurality).

How can the cost accounting brigades be introduced into the technological stream better in order to start up the pipelines on time? Practice prompts the answer to this question. The transportation subdivisions are the link in the technological stream. The brigades of pipe-carrier drivers work by the piece, receiving wages according to a piecework-bonus system for the number of pipes transported on schedule. The work of the riggers and pipeline machinists is paid by the hour. This discrepancy inflicts great damage. The drivers "reduce" the standstills by throwing the pipes in the snow. Then the builders have to pick them out, disrupting the schedule of their own work. Elimination of organizational discrepancies in this case consists of including the loading-unloading links in the cost accounting brigade.

The trade unions promote the development of cost accounting in the brigades. In the opinion of the chairman of the Tyumen' obkom of trade unions, P. Bol'sherotov, difficulties in its introduction (besides those noted) develop because of the lack of a fund in the brigade that could be disposed of. A fund of the foreman is formed by position, but not for the brigade foreman, although his function is not smaller. In addition, the brigade, after taking the order, does not have statutes on the regulation, labor regime, etc., while the agencies of the fire inspection, sanitary-technical, water-engineering, legal inspection and technical inspection of the trade union industrial hygiene strictly follow this. It is necessary for the appropriate economic and legal agencies to show interest in this aspect of the problem.

The traditions of the pipeline construction govern the use of the watch or expedition method of working. The first is efficient when the distance between the watch settlement and the base is relatively short. It is primarily used in developing fields. The second provides for movement of the workers in the limits of a large region, and even between regions. Their work cycle is limited by the periods of construction of the facility. The speakers noted the shortcomings and advantages and spoke of the need to develop the expedition method that combines the practice of both.

Currently, G. Shmal' noted, a regime for the workers of 20 days at the facility and 10 at home is being confirmed for the workers. The foreman and the head of the section cannot work in this regime. The engineering-technical workers spend 280-320 days a year at the construction site separated from their families since the staff schedule does not provide for their replacement. The wages of the watch does not correspond to the physical and moral outlays. In order to secure the people it is necessary to perfect wages in the regions of West Siberia.

V. Stanev advanced similar thoughts: the regional coefficient for wages in the Tyumenskaya Oblast is not always used with regard for the natural-climate conditions and the organization of production. After regulating the mechanism for wages, it would be possible to attract skilled personnel for work on highly mechanized oil-conducting structures (the degree of automation at them reaches 90%).

Discussion of the questions of using the expedition-watch method revealed an economic contradiction: despite the great effect realized by the consumers of the construction product, additional expenditures for shift movement, resetting of the equipment, improvement in the social-general conditions and solution of other concomitant problems are placed on the shoulders of the contracting organizations. As B. Trofimov noted, in the final analysis, the expenditures are compensated for by the considerable benefit on the national economic scale. At the same time it is obvious that the losses of builders must be compensated for, in particular by including in the estimates the expenditures for business trips, increases for the mobile nature of the labor, etc. It is also important to increase the stimulating and regulating role of material reward.

Young people mainly work in the construction of main pipelines. The average age of the residents, for example, of Surgut and Novyy Urengoy is 26-27. There are 10 all-union komsomol shock construction sites active in the oblast, including 4 for gas pipeline construction. The needs and concerns of the young people are constantly the focus of attention of the komsomol organizations. This was indicated by the secretary of the Tyumen' komsomol obkom A. Spirin and the head of the headquarters of the komsomol Central Committee, N. Rygalov. They primarily stressed the organization of daily life and rest of the workers and their families. The oblast, in particular, does not have enough palaces of culture and movie theaters. In Tobolsk, for example, the population is 60,000 and has a drama theater, while Nizhnevartovsk has a population of 120,000 but no theater.

There is unsatisfactory supply of such goods as radio receivers, televisions and furniture. Facilities of the social infrastructure, stores, schools, dormitories, etc. are not always built in time and in sufficient quantity. It seems that it is necessary to set up legal responsibility for the interruption in starting up cultural and general facilities. The economic agencies could also be allowed to acquire many objects by clearing.

The lag in this area aggravates the turnover of personnel in addition to their poor-quality selection. During the year, a definite number of workers leave the construction site. Every other one goes to another organization. About 80% of the arrivals do not have a specialty. The economic subdivisions do not pay enough attention to the reception of young families. This causes high internal migration. A. Spirin and N. Rychagov see the elimination of the listed shortcomings in regulating wages and rewards for high indicators in work. Wages for equal work must be the same in different sectors.

The development of professional technical education and tutorship would promote a reduction in turnover. Under the supervision of a tutor and in the brigade, training occurs faster and better than under stationary conditions.

The speeches of the participants in the roundtable discussion clearly express the thought that the activity of the management personnel is evaluated not only from the results of fulfilling the production plans, but also by how the constitutional statutes on improving the conditions of work and industrial hygiene, guarantee of professional traing of citizens, increase in their cultural level, creation of favorable potentialities for rest and the efficient use of free time are realized.

In the closing speech at the 26th CPSU Congress, L. I. Brezhnev expressed the confidence that the creative impetus given by the congress would enrich the work of each collective, each rayon, oblast, republic and the entire country. These words were also addressed to the workers of the West Siberian region.

In publishing the report of the journals that organized the roundtable meeting, the editorial staff expresses the hope that the questions touched upon concerning planning, standardization of consumption of material resources, labor and wages, the regulation of material supplies, the introduction into practice of the construction industry of the achievements of science and technology, and others, will attract the attention of the appropriate economic agencies, in the first place, the ministries. Efficient measures must be worked out to perfect the organization of construction and improve the working and living conditions of the builders. In the final analysis, this will serve to implement the large-scale tasks for the development of the oil and gas complex of West Siberia in the 11th Five-Year Plan.

FOOTNOTES

1. See: PRAVDA, 24 February 1981.
2. PRAVDA, 26 December 1980.
3. See: PRAVDA, 5 March 1981.
4. Analogous material is published in the journals KHOZYAYSTVO I PRAVO, MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE and SOTSIALISTICHESKIY TRUD.

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SYMPOSIUM ON NEW ENERGY SOURCES HELD IN MOSCOW

Moscow LITERATURNAYA GAZETA in Russian No 17, 22 Apr 81 p 13

[Interview with Aleksandr Yefimovich Sheyndlin, academician and director of the Institute of High Temperatures of the USSR Academy of Sciences, on the occasion of the U.N. Symposium on New Energy Sources in Moscow, by A. Udal'tsov, Moscow, 21 Apr 81: "The Sun in Place of Coal? The Wind in Place of Oil? Dialog on Energy in the 21st Century"]

[Text] It seems that everyone today already knows that our reserves of oil, coal, and gas are not unlimited. But what kind of energy future awaits the human race? This question is being discussed these days by some 100 major scientists from around the world at an international symposium in Moscow under the title "The Significance of New and Renewable Energy Sources in Solving World Energy Problems." The symposium was organized jointly by the USSR State Committee for Science and Technology and the U. N. secretariat and is a stage in preparation for the U. N. World Conference on new energy sources. Corresponding member of the USSR Academy of Sciences D. Zhimerin, first deputy chairman of the USSR State Committee for Science and Technology, in opening the symposium said: "We are gathered here to discuss important aspects of one of the most critical problems of our day — the problem of providing fuel and energy for the human race. The Soviet Union considers the U. N. Conference a representative forum for exchanging the know-how that each country has accumulated in this area and for working out scientifically substantiated guidelines in national and international energy policy."

A. Udal'tsov, special LITERATURNAYA GAZETA correspondent, held the following discussion on the energy of the future with academician A. Sheyndlin, one of the leaders of the Moscow meeting of scientists and director of the Institute of High Temperatures of the USSR Academy of Sciences.

[Question] Aleksandr Yefimovich, your institute and you personally are working on key problems of "large-scale energy." For example, your study of the physical properties of substances at high and maximum temperatures, developing magnetohydrodynamic devices for further energy development, and working out large superconducting magnetic systems. I will not try to mention them all. But what is it that makes you and other energy scientists here in Moscow discuss such "minor" problems as the use of wind-driven engines and geothermal water, using the sun to heat residential buildings, and building power plants that use the energy of ocean tides?

[Answer] Don't forget that our institute also works on forecasting the overall development of energy.

[Question] That is exactly what I had in mind. Do your calculations really show that the reserves of oil, gas, and coal are so small that hard times await us in the near future? And why have scientists begun such urgent work on the so-called renewable and nontraditional energy sources?

[Answer] First let us agree on terminology. The principle by which energy sources are divided into renewable and nonrenewable is clear from the names themselves. But with a rigorous approach it turns out that they are not so unambiguous. For example, we consider coal, oil, and gas to be nonrenewable sources only because the present rate of use of them is millions of times greater than the possible rate of formation. But uranium is also a nonrenewable source of energy in the very strict sense of the word.

The concept of nontraditional energy sources is less definite. Here we should include those reserves which are not used on any appreciable scale today even though the possibility of their use has been demonstrated in principle. For example, there are the nontraditional renewable sources of energy, the sun, wind, waves, tides, the thermal energy of the ocean, and biomass. Then there are nonrenewable resources: oil obtained from bituminous sands and combustible shales, geothermal energy, and nuclear energy using breeder reactors.

Now for the problem itself. The essential point is that the swift development of productive forces in most countries of the world has led to a sharp increase in energy consumption. I am not referring to electricity alone, but also to its prime sources, various types of fuel. As long as needs did not exceed customary levels which could be easily satisfied with mineral fuel, it seemed to everyone that things were just fine. Even if some places had no oil, it could easily be bought in other countries. But because the growth of productive forces proceeded at an extraordinary, unprecedented we might say, rate, a number of countries began to experience a shortage of primary energy sources. And therefore the West has quite recently begun talking about a significant shortage of petroleum, a fuel that is convenient for many purposes.

[Question] I think that one of the first signals that there were vulnerable points in the system of world energy supply was the embargo on oil exports imposed by the OPEC countries and the abrupt rise in the price of liquid fuel.

[Answer] Yes, that was 10 years ago, but crisis situations in the energy supply system of the capitalist countries had begun coming to a head much earlier. And today the price of oil is the highest ever, more than $200 a ton.

[Question] In general this is, certainly, natural because some scientists say that the possibilities of increasing the production of fossil fuels will probably be exhausted before the year 2020.

[Answer] Of course, our reserves of organic fuel are not unlimited. But still, I would like to cite some consoling figures. According to the data of the 11th World Energy Conference held in Munich last year, the total amount of organic fuel in the world is more than 13,000 billion tons of standard fuel. Of course, 83 percent of it is coal. The extractable resources, which is to say those that can be economically extracted from the earth's interior, are roughly half of this figure. Although for various reasons mineral extractions will not be able to grow continuously, even with such a high level of consumption as we have today, our extractable resources of organic fuel are sufficient for the foreseeable future. But forecasts indicate that annual world extraction of petroleum will reach its maximum level of 4 billion tons around 1990, and the maximum annual extraction of natural gas is expected in the year 2000. However, extraction of coal can continue to grow for many decades, even though its share in the world fuel-energy balance will probably reach its maximum around the year 2010.

[Question] At this point I have an ecological question. At the recent Ersken seminar in Stockholm, which is held regularly for journalists from the world's leading publications and I was able to attend, scientists from various countries gave reports on the menacing increase of carbon dioxide in the earth's atmosphere. We know that it is formed chiefly by burning organic fuel, primarily coal. The investigators fear that in the coming decades an increasingly dense layer of this gas will form like a glass bell over the earth and ultimately turn our planet into a giant hothouse, because a shell of carbon dioxide allows short-wave light emission from the sun to pass through but prevents the escape of heat rays given off by the earth. As a result the temperature of the planet will rise steadily, which may lead to irreversible climatic changes. For example, a doubling of the content of carbon dioxide (which according to the calculations of specialists could occur by the mid-21st Century given the current consumption of coal and petroleum) would raise the world temperature by 4-5 degrees. Such a warming up would melt large amounts of polar ice and the level of water in the ocean would rise several meters. As a result large areas of the coastal regions of California, Florida, the Netherlands, Japan, France, Germany, and our Siberia would be flooded. Such climatic changes would have dangerous consequences for food production, for the environment as a whole, for human health, and finally, for the very existence of the human race in the future. I know that not all scientists share this point of view. I would be interested to hear your opinion.

[Answer] It appears to me that the fears are exaggerated. It is true that an enormous amount of carbon dioxide is emitted into the atmosphere each year as the result of the large amount of organic fuel burned. If it all remained there,

the amount would increase quite rapidly. But in fact, the carbon dioxide is dissolved in the water of the world ocean and thus removed from the atmosphere. The ocean contains an enormous amount of this gas, but 90 percent of it is located in the deep layers which have practically no interaction with the atmosphere and only the 10 percent in the layers near the surface participates actively in gas exchange. The intensity of this exchange, on which the content of carbon dioxide in the atmosphere ultimately depends, has not been fully clarified today, so we cannot make reliable forecasts. As you correctly observed, scientists today do not agree about the permissible increase of gas in the atmosphere either. In any case, consideration must also be given to factors that influence the climate in the opposite direction. For example, there is the increasing dust content in the atmosphere which in fact lowers the earth's temperature.

[Question] Aleksandr Yefimovich, if there are adequate reserves of organic fuel for, as you put it, the "foreseeable future," then what has aroused the interest in "alternative" energy sources?

[Answer] Everything depends on the degree of optimism...

[Question] And the accuracy of the calculations...

[Answer] And the accuracy of calculations, certainly. For example, we must, of course, think about the climate. But in my opinion, the development of human energy systems will not have a serious impact on climate for at least another 100 years. Therefore, the thermal effect on the atmosphere has generally been exaggerated, especially in various popular science articles. And as I have already said, the amount of carbon dioxide is incorrectly calculated. But I will repeat, there is no question that we must think about the remote climatic future. As for reserves of traditional fuel, I have already said that they are not unlimited, and the peak of extraction is expected fairly soon. Scientists must look at both tomorrow and the day after tomorrow. Working out the energy balance for the first half of the 21st Century is not an easy matter. The use of nontraditional sources will unquestionably broaden the raw material base of the energy system. In some cases these sources are so great in principle, for example solar energy, that they could meet human energy needs for many, many centuries.

[Question] If this source, the sun, is so unlimited and ecologically clean, what is preventing broad use of it? Why must we at the same time work on the ocean, wind, hydrothermal waters, and many other forms? Wouldn't it be better to concentrate on one?

[Answer] It is important not just to have an energy source, but also to know how much a unit of energy received from it will cost. Precisely because the sources are nontraditional, the technology for using them has not been worked out yet, and this, in turn, prevents a reliable technical-economic analysis of alternative ways of energy supply. The principal task of energy system workers is to meet energy needs with minimum total national economic expenditures.

There is also one other reason that it is wise to work on the development of many new nontraditional energy sources at the same time. The point here is that they are unevenly distributed throughout our country and the world. It is possible that it will prove more advantageous for a particular reason to take this energy from some local nontraditional force which has worse economic indicators than to transport some particular form of energy great distances.

[Question] You answered the second half of the question. What about the first?

[Answer] Why we are not using solar energy widely today?

[Question] Yes.

[Answer] Solar energy is a dispersed form of energy. That is the misfortune. We can only receive a few hundred watts of heat from a square meter of the earth's surface. This dispersed form of energy must be collected so that it can be used for practical purposes. We must learn to concentrate solar energy, which at present is very expensive. After all, it is necessary to deploy some kind of technological devices, for example mirrors, semiconductor devices, or photoelectric cells, over large land areas. The units themselves and the land are very expensive. The ultimate question is: in technical-economic terms, how promising is the use of solar energy? This is what scientists are discussing. For the present I am convinced that solar energy to produce electricity cannot compete with other methods which exist today. I emphasize, though, that this refers to use to produce electricity, and I mean on a large scale. Yet for local purposes, at places in the mountains and deserts where self-sufficient energy sources are essential, it is already applicable today. And what I have said certainly does not mean that we do not need to work in this area. Perhaps in a few decades a "cheap" solution to the problem will be found. But today our institute, in particular, is concentrating its work on building solar heat supply systems and carrying out a major program to design residential buildings with solar heating and hot water. In the more remote future two types of solar power plants may prove profitable: units that work on a thermal cycle and units with direct photoelectric conversion of the sun's radiation into electricity. Advocates of the introduction of photoelectric convertors promise that the cost of these units will be cut almost 10 times in the coming decade. This would radically change the attitude of energy worker specialists toward them.

[Question] What is your attitude toward all the ideas that seem fantastic today? I read recently in the foreign press that the Americans are working on a project to obtain a large amount of electricity by putting special energy satellites in orbit which would accumulate solar energy, convert it to electricity, and transmit it to earth by microwave emission. There are probably other similar projects.

[Answer] As for all the semifantastic ideas, we have plenty today just as there were plenty in past times. I do not want to talk about how likely it is that these ideas will meet the fate of many of Jules Verne's projects.

[Question] Okay. Then, which of the nontraditional energy sources seem most promising and efficient to you today?

[Answer] Of course, the most efficient way to use nontraditional energy sources is to build atomic power plants with breeder reactors. These projects are being conducted intensively in the Soviet Union and various other countries such as France and the United States. Our country has operated the large breeder reactor at Fort Shevchenko on the Caspian Sea for several years now. A similar reactor has been built at the Beloyarskaya atomic power plant.

[Question] But are there any limits to the development of atomic energy?

[Answer] As for contemporary thermal neutron atomic power plants that use the energy of uranium, I have already said that the reserves of this fuel are not unlimited. There are limits. Nonetheless, the path to widespread introduction of atomic energy is open. If we are talking about breeder reactors, fast neutron reactors, and thermonuclear energy, a great deal more needs to be done in this area with respect to both the development of the reactors themselves and organization of the fuel cycle.

[Question] Of course, building thermonuclear power plants would offer unlimited prospects for electricity production. But the earth's heat regime has developed a balance over millions of years taking account of the energy received from the sun. Therefore, some scientists believe that an evaluation of the long-term scale of use of nuclear energy in its ecological aspect demands that the problem of thermal "pollution" from atomic power plants be solved first. There is much talk in the world, especially in the West, of the danger of atomic energy.

[Answer] To begin with the heat problem, because contemporary atomic power plants work at relatively low efficiency, a very large amount of heat is indeed released into the bodies of water which are used to cool the atomic plants. These bodies of water, of course, become overheated, but they can be used effectively, for example to breed heat-loving fish species. As for the danger, no scientist in the world can tell you that there will never be an accident at an atomic power plant anywhere. But the problem of safety receives the most serious attention at atomic power plants. These installations are very reliable everywhere in the world. Certain emergency situations can occur, but this is always foreseen in safety programs. I must say that many industrial enterprises and conventional thermal power plants are just as dangerous as atomic power plants according to appropriate calculations. The issue of atomic power plants is debated with such fervor abroad because unenlightened people associate atomic energy with the atomic bomb. I am familiar with the situation relative to this issue in various countries, and am inclined to say that a great deal of political manipulation takes place related to the problem of building atomic power plants. There are politicians in the West who understand the essential points very well and realize the need to build atomic power plants, but they stir up the problem, using public opinion for their own ends, which are far from scientific ends.

[Question] Aleksandr Yefimovich, in our day when almost everyone has a motor vehicle and, as we now learn, in an age of rapidly diminishing oil reserves, we also must mention the problem of converting biomass to liquid fuel. At the seminar in Sweden we were shown an experimental device for direct conversion of biomass (sawdust, straw, twigs, algae, and grass) into liquid fuel. The device can be used in motor vehicle transportation. According to calculations by Swedish scientists, 10 percent of the territory of the country used to raise biomass could provide the Swedes with a fuel source independent of other countries. Or here is another, completely untraditional method which I heard about in West Germany — converting all kinds of waste material into fuel. According to calculations by West German scientists, just the domestic garbage thrown away by West Germans every day contains as much energy as is produced in the country by all existing atomic power plants. And speaking generally, we are waging such a stubborn and not always successful struggle to find new sources of energy. Wouldn't it be better to take an entirely different course and work toward effective energy conservation? After all, studies have shown that conducting an effective energy conservation policy could supply energy by the year 2000 to allow a 30 percent increase in energy consumption.

[Answer] The introduction of new energy sources and energy conservation policy are not mutually exclusive. No matter what we may do to broaden the energy resource base, the times demand that we conserve energy by every possible means. But this is not the goal in itself. Ultimately, we must take those measures which provide the greatest total savings of capital. For example, it is possible, of course, to reduce the use of heat to keep houses warm by improving thermal insulation, but this also requires expenditures, and significant ones. Only technical-economic calculations can tell us which is the optimal solution.

This also applies to the problem of recycling waste. Of course it contains energy. But ultimately it is economics that will decide where it is wise to use it. For example, already today some large mechanized livestock farms have switched, with full economic justification, to supplying their own energy which they extract from animal waste. Or take most of the tropical countries, where plants grow quite quickly and abundantly. In those place biomass can produce a great deal of useful energy today, and it could produce even more.

[Question] I know that the world's first power plant using a magnetohydrodynamic installation being developed at your institute will be built near Ryazan'. What is the advantage of such power plants for development of the energy system?

[Answer] The laws of physics tell us that the efficiency of any device that converts heat into energy is a quantity proportional to the peak temperature of the working body. Steam turbine power plants have now reached their maximum efficiency, and we must search for a way to convert heat into electricity that will allow us to use a higher temperature level. Magnetohydrodynamic generators working together with steam turbines will help us do this. The efficiency of these power plants should be 50 percent higher. If we think of the future of the energy system, we must not only search constantly for new sources of electricity, but also find a more efficient way to use existing sources. In this respect the magnetohydrodynamic method is at present the only way this can be done for large-scale power systems.

So there are three ways to solve the world's future energy problems: finding new energy sources, more efficient use of existing sources, and finally, rational expenditure of the energy produced.

[Question] One last question. If we were to find ourselves today in the mid-21st Century, how do you think our houses would be heated? What energy sources would we use to cook food? What kind of fuel would we use for transportation?

[Answer] In all of the matters that you mention, I hope that people in the mid-21st Century will be served by electrical energy obtained from atomic, solar, and possibly thermonuclear power plants. Electricity today accounts for about 25 percent of all energy consumption, and by the year 2000 it should, according to forecasts, rise to 40 percent. I think that this trend will continue into the next century.

It is possible that some kind of artificial energy carrier will appear as a middle link between the power plant and the consumer. This could be hydrogen, for example, which is much discussed today. This substance, obtained from simple water at the primary power plant, could be transported by pipes, which in some cases would be cheaper than the transportation of electricity. Hydrogen could satisfy all the personal needs now met by natural gas or oil. It could be used as a fuel for motor vehicles and aircraft. It is likely that in the future other synthetic substances manufactured on a hydrogen basis will also serve as such energy carriers. And it is possible that the human race will discover fundamentally new sources of electricity which we today do not even suspect.

Who would have thought 50 years ago that atomic power plants would be operating successfully throughout the world today?

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